Ground Adjustment and Hydrological Surface Expressions in the Preston New Road Corridor, Lancashire: Observations from LiDAR Differencing and Field Survey

Technical briefing note

Data sources: Environment Agency national LiDAR programme (2018–2022), aerial field observations (2017–2026), and published seismic studies relating to Preston New Road operations.

Executive Signal Summary

Purpose

This document summarises spatial observations derived from LiDAR elevation differencing (2018–2022), repeat ground observations, and published seismic studies that together indicate a pattern of ground adjustment and hydrological change within the Preston New Road corridor in Lancashire.

These observations span a multi-year period and include repeated documentation of the same locations across multiple observation epochs.

The observations are descriptive rather than interpretive. The document does not determine mechanism, environmental impact, or causation. Its purpose is to place structured observations on record and to indicate patterns that may warrant further investigation.

Key observations

Multiple independent observation streams indicate spatially organised ground adjustment and hydrological change in the vicinity of the Preston New Road well site:

• LiDAR elevation differencing between 2018 and 2022 identifies localised negative elevation change across several locations surrounding the site.

• Newly persistent standing water bodies correspond spatially with zones of downward elevation change.

• Field observations document recurring surface expressions including depressions, seepage emergence, sediment staining, and discharge point migration.

• Published seismic studies confirm that hydraulic fracturing operations at the site activated a nearby fault and produced a magnitude ML 2.9 earthquake in 2019.

High-resolution imaging of the ML 2.9 August 2019 earthquake induced during hydraulic fracturing operations at Preston New Road is documented in Seismological Research Letters (Kettlety et al., 2020). *doi: https://doi.org/10.1785/0220200187*

Why this may warrant attention

Observations presented here extend beyond the engineered well-pad footprint and appear spatially organised along drainage and infrastructure corridors.

In low-gradient sedimentary landscapes, surface manifestations such as seepage emergence, sediment mobilisation, and localised depressions can represent zones of localised groundwater discharge reflecting behaviour within the shallow hydrogeological system.

Taken individually, each observation may have multiple explanations. However, their spatial recurrence and temporal persistence indicate a pattern that may merit independent hydrogeological and geomechanical review.

Additional reports can be found at https://groundtruthgovernance.wordpress.com/reports/ These documents provide further spatial and temporal context that may assist in evaluating the broader hydrogeological setting of the observations presented here.

Location

The Preston New Road shale gas site is located within the Fylde coastal plain in Lancashire, UK. The surrounding landscape consists of low-relief agricultural land intersected by drainage channels and minor infrastructure corridors.

The Fylde coastal plain is characterised by gently sloping terrain and a shallow groundwater environment influenced by Quaternary glacial and post-glacial sediments overlying older bedrock units. In such low-gradient settings, groundwater flow is typically slow and interacts closely with surface drainage features, agricultural land management, and artificial drainage infrastructure.

Groundwater levels across low-relief coastal plains such as the Fylde are often closely coupled to drainage networks, meaning shallow groundwater conditions can respond sensitively to drainage management, seasonal recharge, and minor variations in surface elevation.

As a result, shallow hydrogeological systems in these landscapes may influence surface conditions through localised groundwater discharge, seasonal saturation, and sediment mobilisation where hydraulic gradients intersect the land surface.

Figure 1: Regional context of the Preston New Road study area. Satellite imagery (Google Earth, August 2021) showing the landscape surrounding the Preston New Road well pad. Yellow markers indicate documented locations where surface manifestations have been observed within watercourses and engineered environments including roadside verges, embankments, junction margins, and landscaped ground. These points represent specific locations examined in detail in the accompanying study and are representative of similar manifestations observed across a wider corridor within the study area. The blue pins correspond to figures in this document.

Operational history

Hydraulic fracturing operations were conducted at Preston New Road between 2018 and 2019.

During these operations a sequence of induced seismic events was recorded, culminating in a magnitude ML 2.9 earthquake in August 2019. Subsequent seismic analysis indicates that hydraulic fracturing activity activated a nearby fault through fluid pressure transmission.

Geological and hydrological setting

The site lies within a low-gradient coastal plain environment where shallow groundwater conditions and surface drainage behaviour are sensitive to minor elevation changes.

In landscapes of this type, small variations in ground level or subsurface flow pathways can influence surface water expression and drainage behaviour.

Remote Sensing Observations

LiDAR elevation differencing (2018–2022)

Public LiDAR datasets from the UK national LiDAR programme were processed to compare ground elevation between 2018 and 2022. Raster elevation models were created, aligned and differenced to identify vertical ground change across the study area.

These datasets were analysed at their original 1m spatial resolution. The analysis therefore prioritises preservation of the original signal over removal of small artefacts, allowing independent reviewers to reproduce the results. However, extreme outlier values were masked where necessary to reduce water-related artefacts and limit processing demands. As such, flight lines and other standard LiDAR artefacts may remain visible within the dataset.

LiDAR analysis indicates several zones of negative elevation change surrounding the Preston New Road site.

Documented values include:

• ~6 cm localised depression north-west of the pad;
• ~8 cm negative contour west of the pad;
• ~10 cm downward change in fields west of the site;
• standing water bodies recurring within depressions of ~12 cm negative elevation change at multiple locations across the corridor.

These elevation differences correspond spatially with areas where surface water accumulation has been observed.

The spatial correspondence between centimetre-scale elevation change detected in LiDAR differencing and the locations of recurring surface expressions observed in the field suggests that the documented features are not randomly distributed across the landscape. Instead, they appear to form a coherent pattern within the broader drainage and infrastructure corridor surrounding the Preston New Road site. In low-relief coastal plain environments such as the Fylde, even small variations in ground elevation can influence surface water behaviour and shallow subsurface flow pathways.

The repeated occurrence of depressions, standing water, sediment emergence, and discharge migration within areas of measured surface lowering therefore indicates a spatial relationship between observed hydrological expressions and subtle ground adjustment detected in the LiDAR record. These observations remain descriptive and do not determine mechanism or causation but indicate a pattern that may warrant further independent hydrogeological and geomechanical investigation.

The magnitude of the observed elevation differences is comparable to, or greater than, typical vertical uncertainty reported for repeat LiDAR DEM differencing at similar resolution.

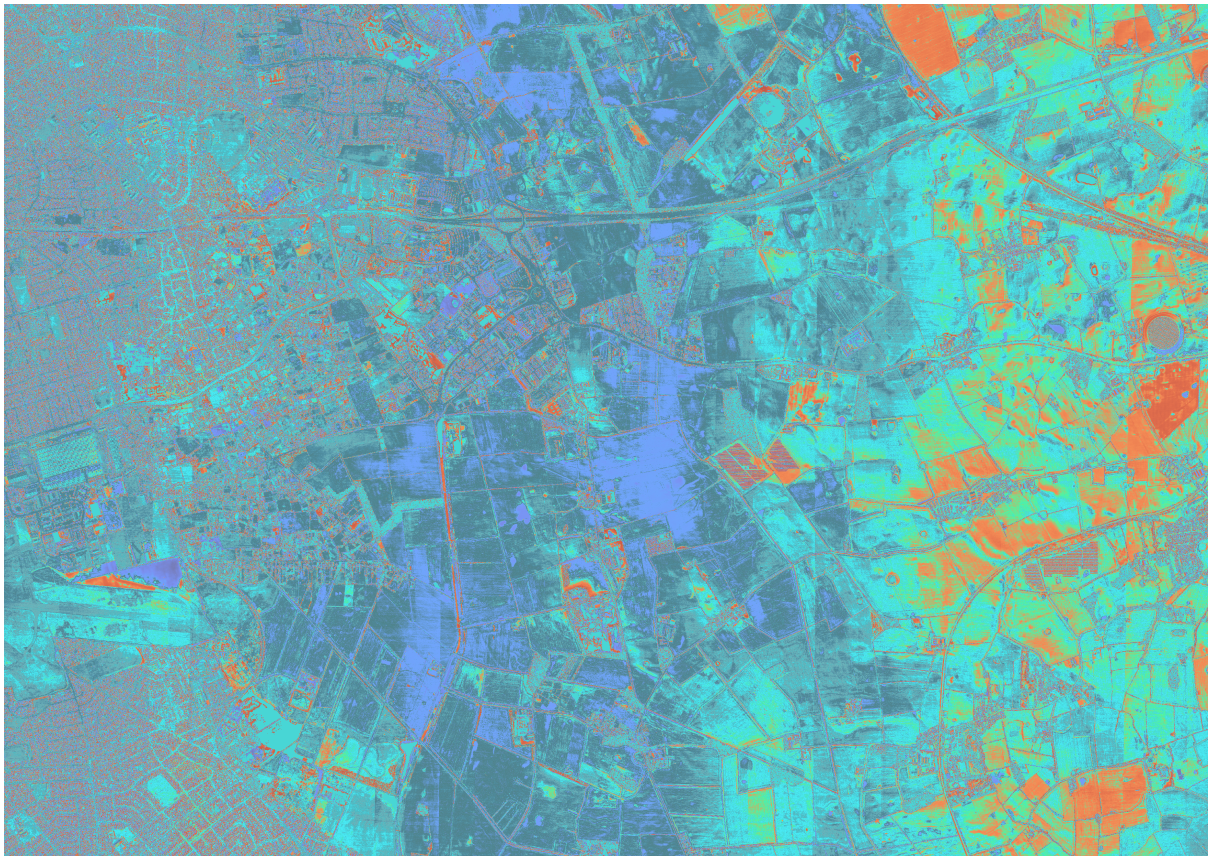

Figure 2: LiDAR-derived elevation change (2018–2022) across the central Fylde study area. Colours represent relative surface elevation change derived from raster differencing of Environment Agency LiDAR datasets. Blue–cyan tones indicate relative surface lowering, while green–orange tones indicate relative surface elevation increase. The spatial pattern highlights a broad deformation corridor extending through the study area, including features that continue beneath engineered environments west of the Preston New Road site. Colour classes correspond to the symbology used in the raster layer.

Key to LiDAR ΔDTM classes

These observations indicate measurable ground adjustment within the broader study area during the 2018–2022 period.

Surface Observations

Ground and hydrological features

Field observations conducted between 2017 and 2026 document a recurring set of surface expressions across the Preston New Road corridor.

Observed features include:

- localised depressions;
- seepage emergence;
- sediment staining;
- bank erosion;
- surface mounding;
- migration of discharge points along drainage channels.

These features occur across multiple locations distributed within the surrounding drainage and infrastructure landscape.

The recurrence of similar surface expressions across multiple sites suggests spatial organisation rather than isolated surface defects.

Evidence of Progressive Ground Adjustment and Subsurface Flow Reorganisation around Preston New Road, D. Nye 2026

Figure 3: Aerial view of a localised sediment emergence within an agricultural field in the study area. The feature consists of exposed fine sediment and disturbed vegetation forming a central mound-like structure with a short downslope sediment spread. Lat: 53.791383° Lon: -2.946614°

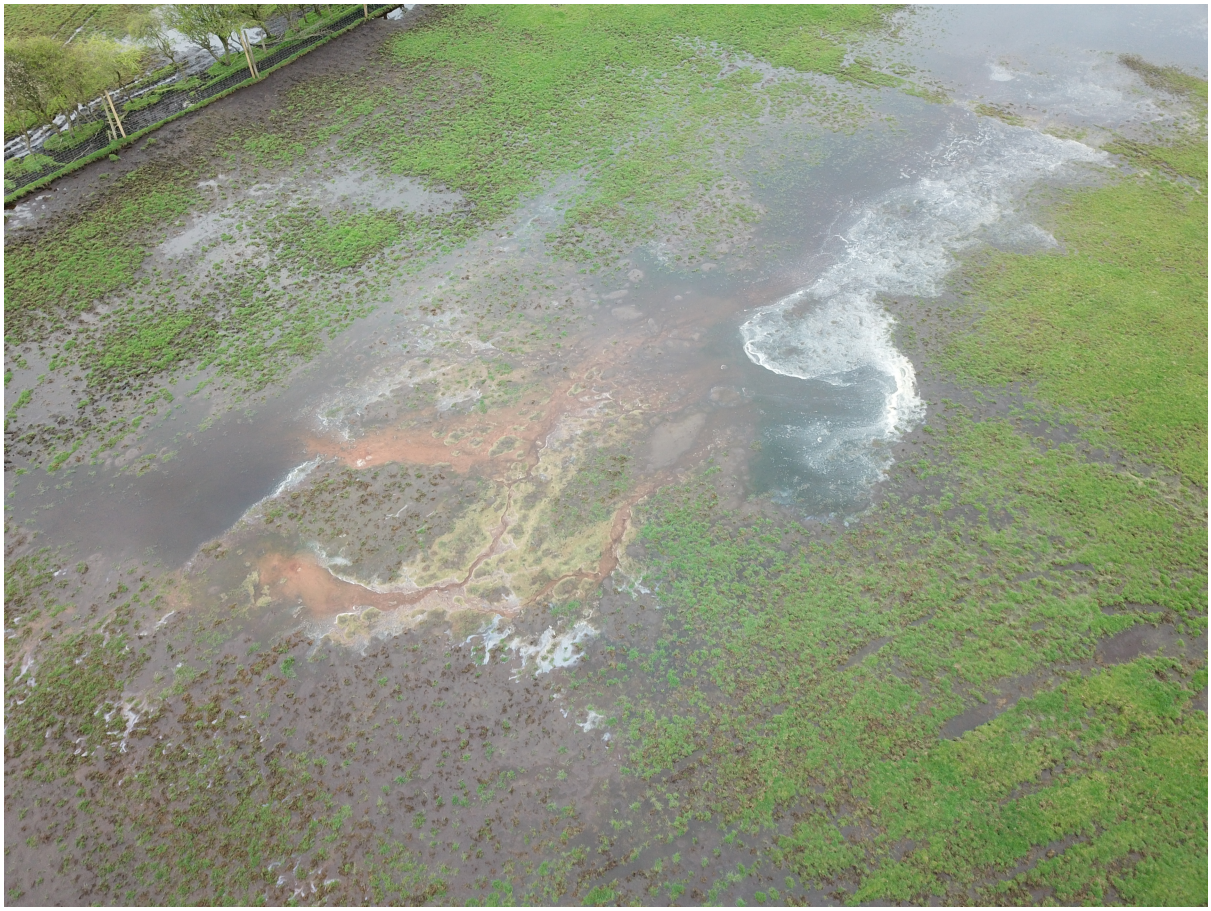

Figure 4: Localised water and sediment emergence observed in April 2018 near the Wakepark site. Aerial imagery shows sediment-laden water emerging within a saturated agricultural field, forming branching surface channels and foam accumulation indicative of sustained flow. LiDAR elevation differencing indicates that the feature occurs within a shallow linear depression extending toward the Main Drain, with localised surface lowering on the order of several centimetres. Lat: 53.796883° Lon: -2.964731°

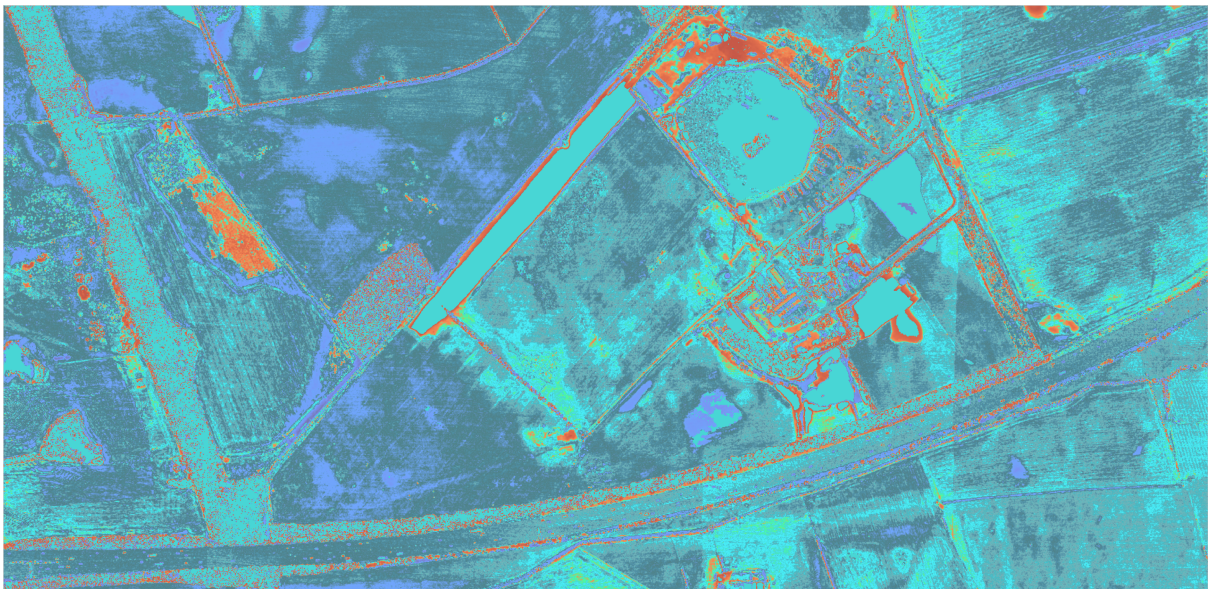

Figure 5: Wakepark site context in LiDAR elevation difference data, showing the location of the April 2018 water and sediment emergence feature within a shallow linear depression aligned toward the Main Drain.

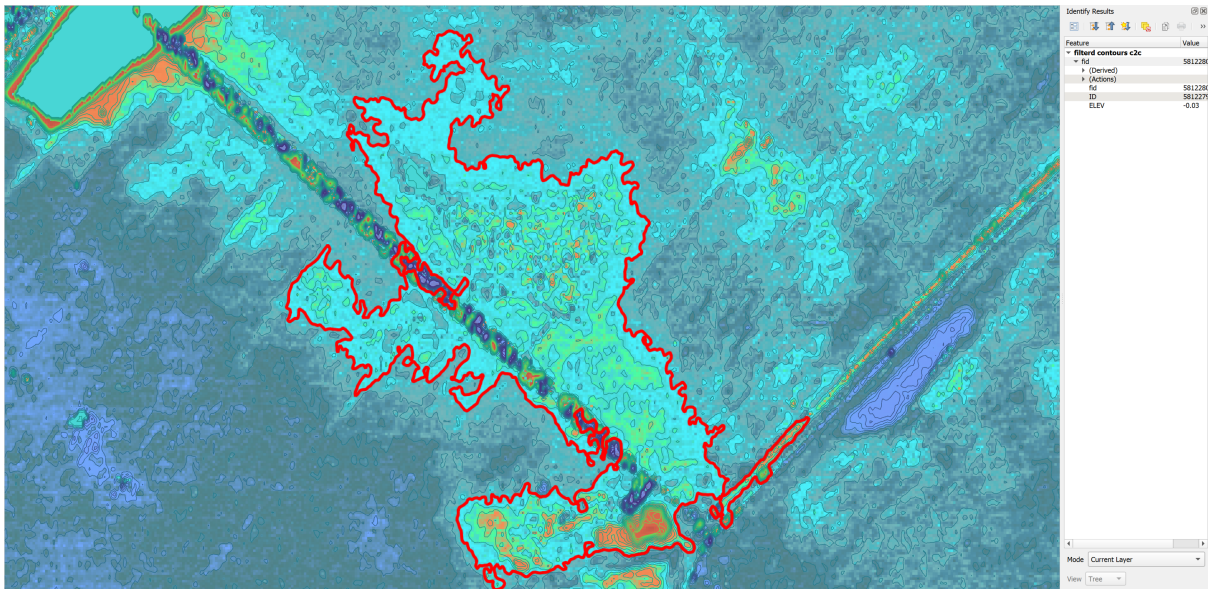

Figure 6: Local LiDAR contour detail at the Wakepark site showing a shallow depression of several centimetres associated with the emergence area identified in aerial imagery.

Field observations also noted reddish sediment accumulation within a damaged section of the field drain outlet. The sediment colour appears similar to material observed in nearby emergence features, although this observation was not investigated further within the scope of this report.

Figure 7: Recurring surface disturbance at the same field location observed in 2017 and 2026. The earlier image (above) shows a localised water-filled depression, while the later image (bottom) shows exposed sediment and ground disturbance at the same site. Lat: 53.790946° Lon: -2.973780°

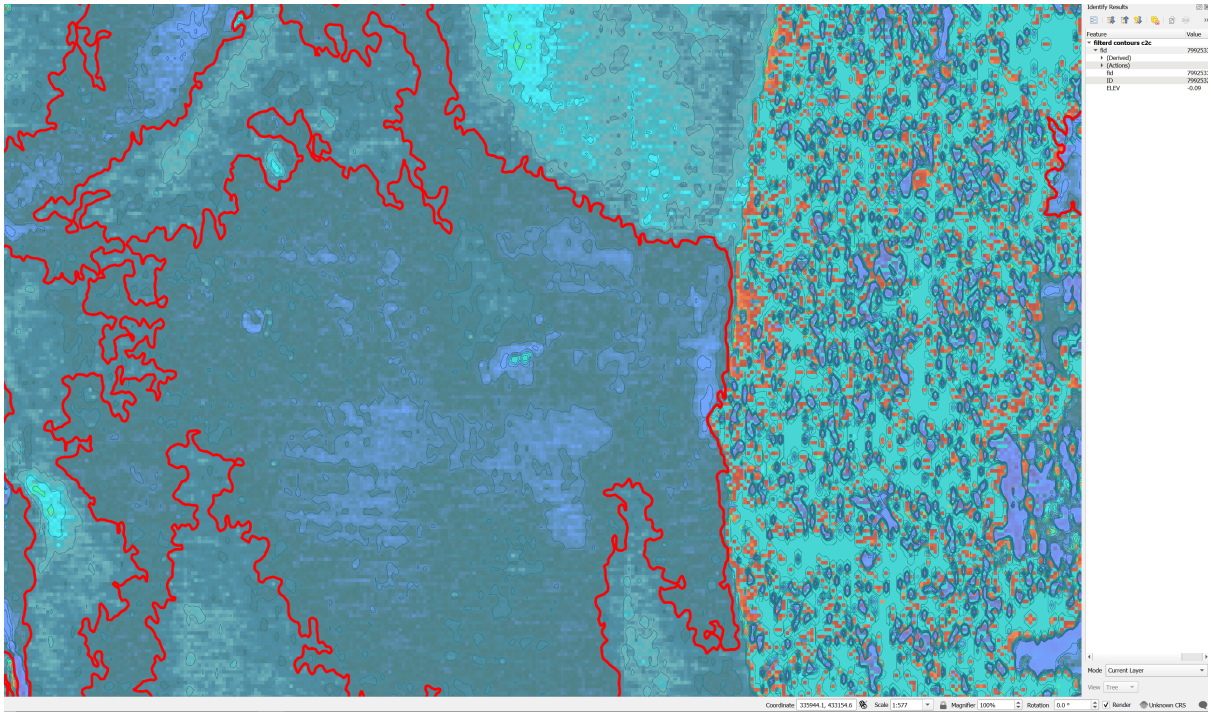

Figure 8: LiDAR elevation difference of the field in Figure 7 showing a coherent localised depression within otherwise uniform agricultural ground. The outlined feature indicates surface lowering on the order of approximately 9–12 cm.

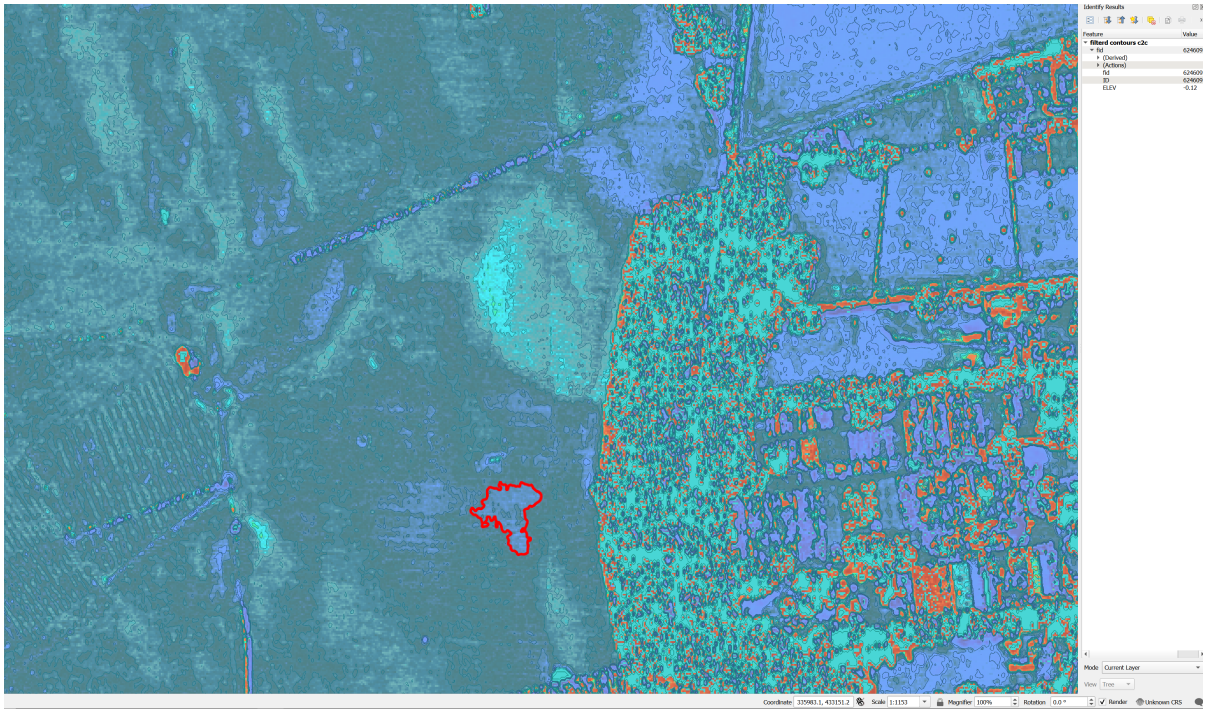

Figure 9: Local contour detail of the seep feature in Figure 7 showing field-scale depression geometry and a smaller adjacent seep/depression feature within the same area.

Interpretation Limits and Next Steps

Interpretive boundaries

This document does not determine mechanism, environmental impact, or responsibility.

The observations presented are descriptive and are intended to document spatial and temporal signals within the study area.

Several processes could potentially produce similar surface expressions, including groundwater emergence, soil erosion, drainage modification, or subsurface ground adjustment.

The purpose of this document is not to advance a specific mechanism, but to document spatial and temporal signals that may benefit from specialist hydrogeological assessment.

Questions for further investigation

The observations presented raise several questions that may benefit from independent review:

• Are the observed elevation changes consistent with regional ground movement or localised deformation?

• Do the observed surface expressions correspond to subsurface groundwater pathways?

• Is the current monitoring framework sufficient to detect distributed hydrogeological responses in the surrounding landscape?

Suggested next steps

Potential next steps could include:

• independent hydrogeological assessment;

• targeted ground monitoring;

• verification of current subsurface conditions prior to further site disturbance or deconstruction activities;

• comparison with additional LiDAR epochs as they become available.